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Arts & Industries N^o 1

PAPER - MAKING IN CANADA.

The Origin, Rise and Progress of
Paper Manufacture.

MILLS OF THE
CANADA PAPER CO'Y
OF MONTREAL.

THE PROCESS OF PAPER-MAKING
FULLY DESCRIBED.

Head Office, 372 to 376

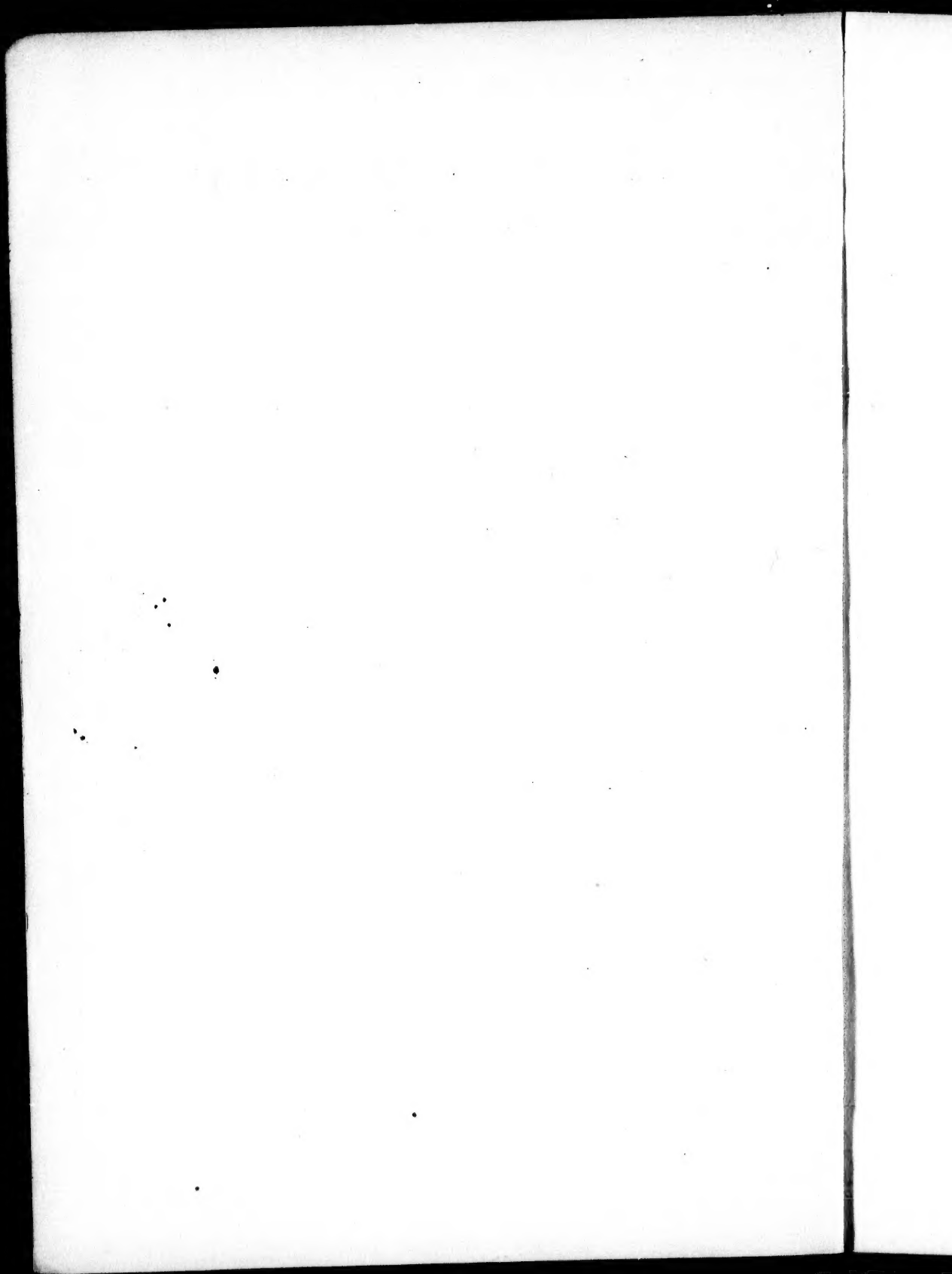
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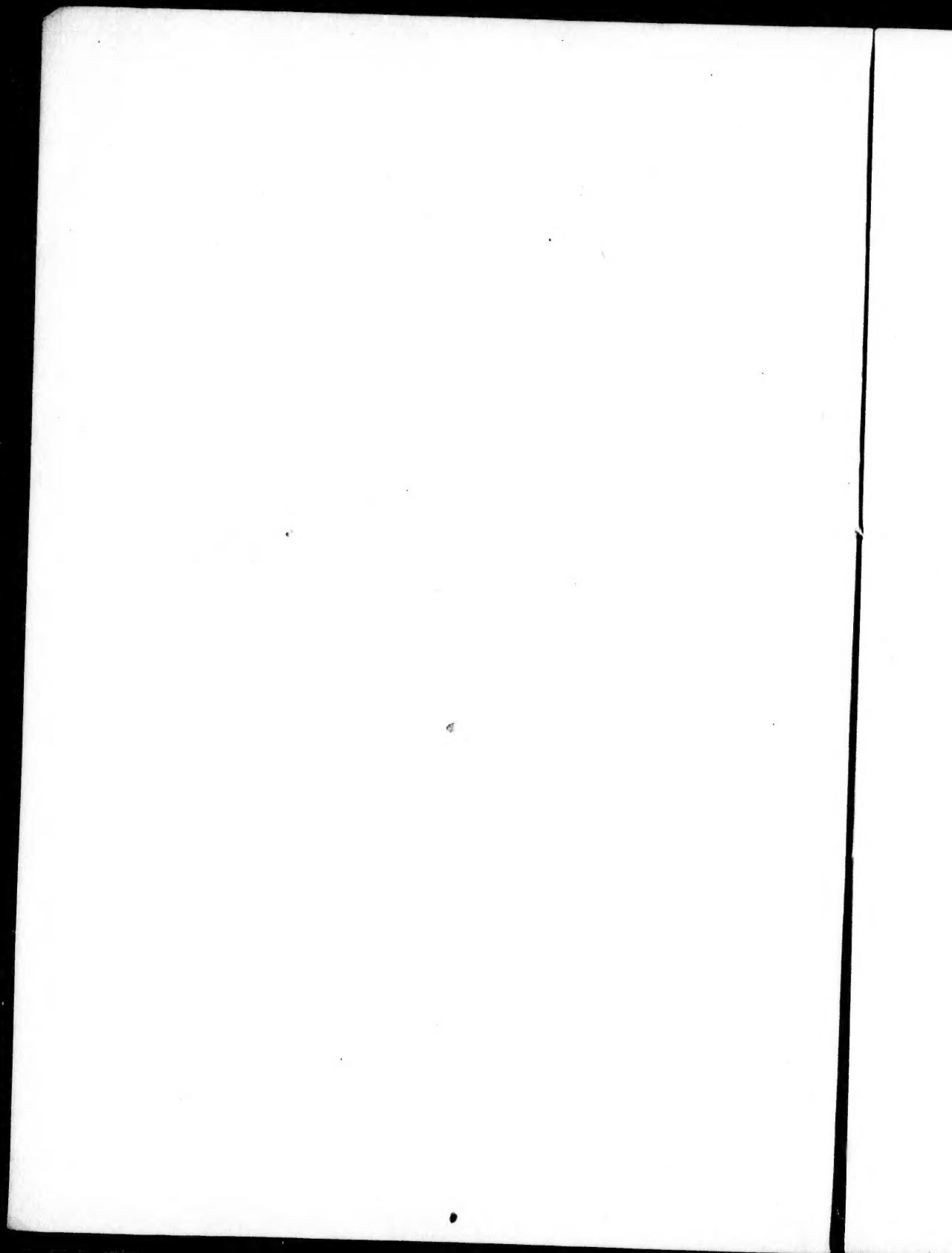
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PAPER-MAKING IN CANADA.

Description of the Mills of the Canada Paper Company
at Sherbrooke, Windsor, and Port Neuf, Quebec.

Introductory—Paper and Paper-Making— Rise and Progress.

The industries of a country are always of interest to its people. No apology, therefore, is needed for the following account of paper manufacture, an account bearing particularly on its development in Canada. To make the story of general interest and usefulness, a brief introductory reference to its salient points is given. Ask a philosopher what has caused the wonderful progression of the human race in the past three hundred years, and he will tell you that it has been the invention of the printing press. Ask him again why the most literary nations have ever been the most advanced and powerful, and he will tell you that

THE PEN IS MIGHTIER THAN THE SWORD.

You leave him, satisfied with these sonorous platitudes still sounding in your ears, and never give a thought to the medium which alone has rendered pen and printing press useful to mankind, to the paper which has transmitted their impression abroad. The active principle, as usual, bears away the credit; the silent, passive agency is taken for granted. But it must still be there; the locomotive requires the rails, the commonwealth its unwritten code, the man a future hope, all silent yet indispensable, just as our philosopher's pen and press require a passive material to perfect their usefulness. The material is paper, and of paper we are about to write. Three thousand years ago, so far as we know, the human race first attempted to write, and like all beginners went heavily into details, to the destruction of the general effect. The attempt was to engrave their writing on flat stones, but from this they soon passed to clay tablets, which were impressed while soft and afterwards dried and hardened in the sun or in kilns, much as are our bricks. Layard, (now Sir Austin, British Ambassador in Turkey) whose researches in the buried cities of the long gone Assyrian empire first made him famous, found among these remnants of time

HUNDREDS OF CLAY TABLETS

turned to stone by the lapse of years. Such means of writing alone seem to have been known to the Assyrians, but it is certain that about the same time many other methods were practised; a species of paper was made from intestines, another from leaves, a third from skins—human skins sometimes. Stee

or ivory plates, scored with a graving-pen, are still extant. But the Egyptians, whose strange civilization grasped all things, even to the prophecies of the world's end, which, according to some, are embodied in the pyramids, could not rest content with such barbarous inventions; and first produced the papyrus which has given its name to our modern substitute for it. Two thousand four hundred years ago papyrus began its career, to last till the parchment of the later Roman Empire superseded, and the paper of the European twelfth century mills destroyed it. The Nile, which made Egypt, made also papyrus. In its waters grew a tall plant, ten to twenty feet in height; the stem three-cornered, soft, and built of almost imperceptible layers of thin material. Cutting down these stems the Egyptians separated the layers by pointed mussel-shells, or by less romantic pins, and spread a series of them upon a table sprinkled with the Nile water. Across this series was laid transversely another row and the double thickness flooded with water again, after which a heavy pressure was put on the sheet. Polished finally by some hard substance,

THE MAKING OF THE PAPYRUS

was completed; and from its native banks it migrated to all ends of the recognized world, comparatively not very far distant, any of them. Upon the process just described the Romans greatly improved, and under their rule Alexandria became the great paper mart of the now enlarged civilized earth. But the use of parchment was never discontinued by the stern rulers of the world. There seems not to have been one single step taken in the march of European progress which was not anticipated by the Egyptians or, still more, by the Chinese. That peculiar people—inventors of gunpowder, of printing, of canals, of steam-engines—were also the first to discover the art of paper-making from fibrous matter reduced to a pulp in water. At any rate, they used such a paper 1,800 years ago; our British ancestors did not then possess even the rags from which to make such a material. However, the Chinese did not use rags much, for the chief constituent of their article was the inner bark of the bamboo and mulberry trees, which were put through an elaborate fifteen days' process, and did not afford a remarkably good paper after all. The operations of the Japanese hardly resulted more satisfactorily, although they have anticipated the notions of our present manufacturers by turning their paper to strange uses, among other things making waterproof clothing from it. On the other side of Asia the Arabians

EARLY BEGAN TO MAKE PAPER,

obtaining the idea from China; and shortly after the death of Mahomet, and while his followers were ravaging the world, a manufactory of the substance which was to revolutionize it was started in Samarcand. This date, A. D. 706, is the first in the history of paper; the second occurs in the eleventh century, when a mill was started in the limits of the Greek Empire. The Arabs early carried the manufacture into Spain, from which it spread over all Europe, and after the invention of printing rose to huge dimensions. The first mill was built in England in 1558; the first in America in 1690. Not at all confined to rags and bark have been the experiments upon the making of paper. The most extraordinary substances have been tested and abandoned, the one after the other. Cotton stalks, cabbage stumps, flax, gutta percha, and hornets' nests; ivory shaving and lime, seaweed and oakum have all had their chance and are but a tithe of the materials tried. But, until lately, little addition was made to the resources of the manufacturers, and the direction in which the only material

advance was effected was in the improvement of the machinery. This, however, was wonderfully rapid; in less than fifty years the hand-mill has been replaced by the vast establishments, and

PONDEROUS MACHINERY OF THE PRESENT DAY,

and twenty years ago the annual product of the world's paper manufactories was over half a million tons. No reliable statistics of later date are rapidly obtainable, but the increase must since that have been great. To turn, however, to the manufacture itself, there is in all paper-making one principle—the rendering consistent and homogeneous a thin watery pulp. Yet the manufacture, though of all manufactures the most interesting to witness, is complex and hard to describe without plates; the reader will understand this when the making is reached. The principle given, however, underlies one general process. A fibrous material is cut, and bruised, and tortured, in water and bleaching fluids, until it is reduced to a fine pulp; this pulp, or rather fluid, is run over a succession of wire cloths until the superfluous liquid is gradually drained off. The resultant damp sheet then passes under pressure through a drying process, and the original filaments of the fibrous matter are thus so interwoven and knitted together that they cannot be separated, and

FORM WHAT IS CALLED PAPER.

As before stated, the first mill mentioned in the annals of the New World was established in 1690. As the Yankee was an unknown species in those days, the mill could not, of course, be established by one; and that honor belonged to a Dutchman, William Rittinghuysen. Rittinghuysen built his mill at Roxborough, near Philadelphia, upon a little stream which is known to this day by the name of "Paper-mill Run," but the Dutchman's mill has long disappeared, and we know now of it and of him only through the frail product which both probably looked on with a certain contempt for its unsubstantiality. But that single mill was the fore-runner of a vast army of factories, and it is believed that the paper now produced in the United States and Canada yearly equals that manufactured throughout the rest of the world. Of course Canada claims but a comparatively small portion of this annual out-put, but

THE YIELD OF HER MILLS

is still very great. There are many establishments scattered throughout the Dominion whose appliances and products equal those of any in the world. Among the most advanced of these in almost every respect, are the mills of the Canada Paper Company at Windsor and at Sherbrooke, in the Eastern Townships, through the courtesy of whose president an investigation into the process employed in the manufacture was permitted. As already remarked, the description of these processes is difficult, but it is at the same time both interesting and useful.

The Mills of the Canada Paper Company-- Reduction of the Rags—Of the Wood.

The Windsor Mills are situated about fourteen miles from Sherbrooke, in a triangle formed by the St. Francis river and the Windsor river, a little stream, which comes down from the high land bordering the valley of the St. Francis. This stream referred to tumbles into a ravine opening on the large river in a

series of broken and picturesque falls about sixty feet in height. But the term "little" applies to the stream only in the summer; in the spring a flood of black water roars over the cliff and down the ravine in rugged strength. Behind the mills the high land rises perhaps a hundred feet up to the second terrace of the river valley, and conceals the little village of Windsor from sight. When the mills were established fifteen years ago, in 1864, there was not a house outside of a very small village within three miles, except here and there that of an isolated farmer; but Windsor now contains between five and six hundred inhabitants, and there are, besides, many cottages scattered over the hills. From the high ground near the village is obtained

ONE OF THE MOST PICTURESQUE VIEWS

in the valley of the St. Francis; and none who have travelled in summer over the railroad east from Richmond, can have helped noticing the quiet beauty of the scenery in this valley. Looking down upon the St. Francis, the stream emerges close by from behind a projection of the hill upon which you are standing, and winds onward around bluff knolls and through fringes of trees and foliage, varied here and there by green sward, until its glitter is broken by a solitary steeple rising from the lower village of Windsor. Farther on it narrows in its silent course until the last gleam vanishes a league distant among the turns of the hills which environ its course, and which rise from its banks in a series of bold curves until they threaten to lose themselves among the clouds. Looking upwards the eye travels over the mills and the long bridge opposite them, and rests upon a basin in the amphitheatre of the hills into which the river abruptly expands, after suddenly appearing from behind a bluff. Immediately opposite you the slopes are very thickly wooded as far as the eye can reach, and this district supplies the manufactory with the

THOUSANDS OF CORDS OF WOOD

nnually required.* The company owns on both sides of the river some 4 000 acres of land, all of which is forest; but as a rule, they leave this untouched when practicable, and obtain their wood from the neighboring districts.* It is in winter that the cutting of the wood is done, and the scene is one not easily forgotten. The proper weather is the bright and cold time of middle and late winter, when the frozen snow admits of teaming. Everything is, for the time, in a whirl of activity, and the high woodlands resound with the blows of axes and the crashing of trees and the shouts of men; there are usually between three hundred and four hundred men, with more than a hundred teams employed in the work. From the forest the wood is teamed to the great yards near the river and there piled.* The manufactory possesses a saw mill of its own, driven by the water of the stream emptying into the St. Francis.* To secure the saw mill and upper buildings of the establishment from danger during the spring freshets, the company were compelled to erect a strong bulkhead across the course of the stream; and just above this bulkhead is the dam necessary in the late summer to collect sufficient

WATER POWER TO RUN THE MILLS.

Formerly, the water-power held good all the year round, except, perhaps, during a couple of weeks in the hottest part of the year; but of late, as the and along the banks of the stream has been cleared and the forests thinned out, the supply of water has gradually failed, and is now insufficient during nearly a third of the time. Steam is consequently used as an auxiliary. The buildings of the establishment are very numerous, and, as they are built apart as

much as circumstances will permit, in case of fire, cover several acres of ground. They comprise an office, storehouses, saw-mill, furnaces, machine shop, finishing house, "recovery house," liquor house," and the manufacturing establishment proper. This array of shops is explained by the fact that the company depends entirely on itself for everything connected with the manufacturing processes. ✕ The ominous term

LIQUOR HOUSE

is applied to the department in which is made the caustic liquor required in the reduction of the wood. Crossing the St. Francis opposite the mills is a long and substantial wooden bridge, erected by the Company for convenience of access to one of their wood-yards, but which has also proved very welcome to travellers. This bridge is some 500 feet in length, and cost the bridge company \$10,000. For some time the sole return was all in the Paper Company's business, but of late the tolls have given a percentage on the capital after standing all necessary outlay for repairs. The toll is not a very heavy one, but has, nevertheless, afforded some amusing instances of the parsimony of the country folk. Teams are charged five cents each passage, and foot travellers three cents; and this distinction caused the following stratagem on the part of a farmer and his wife living on the opposite side of the river from Windsor. They were accustomed to drive over to the village every week with butter, eggs, &c., and their toll was accordingly ten cents across and back.

THIS WAS EXORBITANT,

and therefore for some time past the worthy couple have alighted and hitched their horses at the far end of the bridge, laden themselves with the contents of their cart, and trudged across down to Windsor on foot about half a mile. This saves them four cents, as each of them pays three cents for crossing. Still they seem to consider it all right, although curiously enough their market days are usually either blazing hot or favored with rain and thunder storms. Another public benefit to the neighborhood is a comfortable hotel near the railway station. The erection of this was also directly in the interest of the Company, however, as by agreeing to build it the Company obtained a promise from the district authorities that no other hotel license should be issued. Consequently although the hotel does not pay directly, nevertheless the sale of liquor in the village is prevented, and the Company's employees kept out of temptation, as no liquor is allowed in the hotel itself. On the opposite side of the road from the hotel, and upon an eminence half hidden by the trees, is

THE HOUSE OF THE FOREMAN

or rather manager of the mills, Mr. Macdonald, the oldest and probably best informed paper manufacturer in Canada. He is jocularly termed the father of paper-manufacture, and is a hale old Scotchman likely to be in charge of his ward for some time to come. It is high time, however, to come to the manufacture itself. ✕ The paper is made from a pulp composed of certain proportions of rags and wood. These proportions, and also the kind of wood best fitted for the manufacture, have been obtained by long and patient experiment. The wood and cloth are each separately brought to a pulp before being mingled in the proper percentage, and we shall just describe the processes through which each passes until the stage is reached in which the amalgamation takes place, and the composite pulp is ready for paper making proper. ↓

THE RAG PROCESS.

The rags arrive at the mills in huge bales of rather unsightly appearance, and are placed in the storehouses until required. From the latter they are taken as needed to the sorting-room, where they are separated into various grades which are used according to the quality of paper to be made. At one time the sorting room was an important department, employing a large number of hands, but since the introduction of wood as the chief constituent of the paper, the glory of the sorting room has departed, much fewer hands being now needed there. The rags pass from it through a series of "dusters" and "cutters," from which they issue in masses of partially cleaned shreds. In the floor of the dusting room is an aperture through which the shredded masses are shovelled into a huge revolving iron boiler in the chamber below; and when the boiler is sufficiently full steam is let in by pipes from the engine house, and the boiler caused to revolve for some time at a high temperature. This process rapidly softens and cleans the rags, and the resulting pulp is placed in the "washing engine," and thence goes through the "bleaching engine." These engines, which are almost identical, are oblong bins about three feet deep. A partition runs lengthwise up the middle, but does not touch either end, so that the pulp contained in the bins can move around them. This it is made to do by the inclination of the bottoms, and by the passage round of a

CONSTANT STREAM OF FRESH WATER,

which, after circulating through and cleansing the pulp, is removed in its dirty state by an ingenious arrangement of wire screws and buckets. The bin also contains an arrangement of knives, which completes the decomposition of the rags. This washing and beating process results in making the finer qualities of pulp of a beautiful white color, and soft and velvety to the touch. In appearance, indeed, it resembles ice-cream more than anything else, and the bins containing the pulp seem to be a wholesale preparation for Sunday-school picnics. Only the very fine rags, however, can be brought to this creamy whiteness, and then only by the free use of chlorine. From the bleaching engines the clean pulp is flooded into the "drainers," where it lies for a while for the double purpose of bleaching and allowing the chlorine liquor to be drained off for use again, after which a second washing makes it ready for addition to the wood pulp, and the final preparatory treatment. To recapitulate: from sorting-room through the "dusters" and "cutters" to the boiler; thence to the "washing" and "beating" engines, and then to the "drainers." Thus are the rags brought to a fit condition for amalgamation with the wood pulp. Dirty, soiled and useless, apparently, these products of the slums and alleys of cities in a few hours come forth from their sharp purgatory as stainless as snow. But the work is as yet only half done, for they are still to be merged in far different material, and have still to undergo long torture before the end be reached.

PREPARATION OF THE WOOD.

But by far the most important constituent of the cheaper paper is wood, and the quantity used in the mills, in one way and another, is almost incredible. On the opposite side of the St. Francis from the mills, and behind the first terrace rising from the river, is the wood-yard, in itself an impressive sight. From the rising ground a clear view is obtained of the yard, and the eye travels wonderingly over hill after hill of wood. There are at times 16,000 cords of wood stored there; the mills annually consume about 10,000 for steam, hot water and paper pulp. The wood required for immediate use is kept in sheds at the factory, which are filled from time to time as their contents are exhausted. It

it simple cordwood. Now, cordwood is a stubborn material, and is usually humored with a saw, or soothed by a due regard for its grain; but it gets little petting in the paper mill. Strongly set upon a revolving shaft is a great 5-ton wheel, with projecting knives running on one side like a spoke from the centre to the circumference. The edge of this knife is parallel to the wheel. The log of wood, placed in an inclined trough, slides down and rests against the side of the revolving wheel until the projecting edge comes round and slashes right across the wood, taking off a clean slice in a moment. Just beneath the knife is a space through which the sliced wood falls into buckets arranged upon an inclined endless chain, the same in principle as

THE BUCKET FRAME OF A LARGE DREDGE—

not dredges of the stamp at present working in Montreal harbor, but the improved deep-water dredges, used in Lake St. Peter. The buckets ascend filled with chips, and empty themselves into a room above as they come over the top of the chain. This room is a long one, and under this floor are a number of gigantic upright boilers. These boilers, beneath which are furnaces, are twenty-one feet in height. The chips from the cordwood are shovelled into these, and a blackish, caustic liquor, which will be afterwards referred to, is poured in on top of them, and fire kindled in the furnaces beneath, until the steam from the liquor causes a pressure of 100 lbs. to the square inch, or thereabouts, on the boilers. This heat is maintained for a certain time, according to the nature of the wood, and reduces the wood to black, sponge-like, semi-fluid masses, which after being properly cooked, are conducted into large tins, and, after being washed there with weak caustic liquor and water, are finally thrown into an agitating stuff-chest, which completes

THE DISINTEGRATING PROCESS.

From the stuff-chest the pulp is pumped up on to a vibrating wire-cylinder, and thence goes through a series of "wet press cylinders," which it leaves in the form of fibrous brown sheets resembling paper, but without much consistence. This is then placed in a large bleaching engine from which it runs into the "drainers," referred to in the rag process, and afterwards receives the final washing. Such is the preparatory treatment; from the choppers to the boilers and bins; then to the stuff chest and wet-press cylinders, and thence to the bleaching engine, and the wood is at last ready for combination with the rag pulp, to which all the above lengthy course has been only preparatory. Indeed, the pulp once ready, the making of the paper is a quick and clean process, and apparently the least important of the many steps taken in the manufacture. But the same rule holds good here as everywhere, that in all work which results in important ends there is a turning point at which the road, long, difficult and seemingly purposeless, suddenly becomes fair and direct and leads at once to the goal. But each previous and almost aimless exertion must be as careful as though everything depended on it; a single mistake in the preparation of this paper pulp, a mis-tint, or want of proper bleaching or cleaning, discovers itself after this critical point and ruins the quality of the paper. It may be mentioned, before going on to describe the final manufacture, that the caustic liquor in which the wood is boiled, and which loses in the boiling much of its strength, is saved and used over again after being renovated in the "recovery house," which will be referred to later.

The Making of the Paper—Uses—The Recovery House—Conclusion.

Stranger than any fiction is the truth of the history of the sheets which the reader now holds in his hand, composed as they are of the most dissimilar elements, and drawn from strangely different sources. In the dirtiest and foulest purlieus of the cities of two continents are gathered the rags—in London, New York, Montreal; and, brought by train and steamer perhaps thousands of miles to a quiet Canadian village, this city refuse joins there material which has lived untainted in the pure atmosphere of the adjacent hills, flourishing through scores of years in storm and sunshine. Henceforth, combined invisibly and inextricably, these strange fellow-travellers go forth from their encounter, and journey abroad, bearing possibly, as now, their own history upon their face. But the union has yet to be consummated. The wood and cloth have, each of them, been brought into a pulpy condition, and are undergoing a final bleaching in the separate "drainers." The commingling, takes place in the Gould or beating engine, an upright boiler, externally not unlike an egg in shape, into which the pulps are put in the required proportions, the wood greatly in excess. Revolving horizontally in this Gould engine is an apparatus with a peculiar arrangement of knives, which

CHURNS UP THE MATERIALS

and perfects their combination; and after remaining in the engine for a certain length of time, the composite pulp is run into huge stuff-chests supplied with agitators, and there diluted with water, and stirred up until ready for the change into paper. Thus treated, the pulp becomes a thin bluish tinted fluid (very little more consistent than average Montreal drinking water), in which very fine fibres and minute pulp are kept suspended by the agitation. Now comes the running this fluid upon the machine (called the "Fourdrenier," from the inventor of that name), which it will leave in the form of paper. It first flows upon fine screen plates which are kept vibrating very rapidly, thus preventing much of the fluid from sinking through. From this screen it passes on to the Fourdrenier wire, which vibrates horizontally in a strong frame. This endless wire is fifteen or twenty feet in length, and runs on rubber Deckles arranged at pleasure to widen or narrow the required paper. The fluid comes upon the wire in a very thin sheet, and as it flows down, part of the water drips through the screen, so that the fluid sheet continues to become more and more consistent, until finally a suction-box at the lower end removes the last unnecessary liquid, and the sheet passing between the great rollers called the first press, becomes consistent and homogeneous. It is supported still further, until, after moving through a series of smaller rollers upon an endless felt, it comes forth fit to be called paper, although very weak, and as easily torn as saturated blotting paper. It should be remarked that all the fluid which sinks through the wire in its passage is

COLLECTED IN TANKS BELOW,

and used over again, so that here as in every stage of the manufacture, from the raw material to the finished product, every loss is provided for and no waste permitted. Such is the simple process which changes a thin liquid into a material from which carwheels may be made. The sight of a cascade of bluish water transformed in a few seconds into purity and consistency is one so inter-

esting and so strange that the spectator finds himself contentedly watching it while time rolls on, until he is probably awakened from his day-dream by finding his feet wet from the spray of the screen. As might be inferred, however, one peculiarity of the fluid is that it dries very quickly, and in a few minutes no trace of the soaking remains. From the first press on an endless felt, the paper moves through a succession of huge revolving cylinders heated by steam; these are called the "drying cylinders," and the paper is kept in close contact with their surfaces for a "drying canvas" which moves with it. A curious effect is produced by the friction caused by the paper passing between these cylinders. It leaves them to go through a series of chilled iron finishing rollers, called calender rolls between which and the drying cylinders is a space of four or five feet over which,

NOW STRONG AND COHESIVE.

the paper passes unsupported. If the hand be placed beneath the passing sheet a somewhat strong thrill or shock is felt, caused by the electricity generated by friction referred to. It might be worth while considering whether the generating power could not be fostered as to produce it in quantities sufficient to afford a practical result. To return, however, to the paper: the sheet now winds through a vertical frame of calender rolls, which give its surface a certain finish; and the edges are afterwards trimmed and the paper cut the proper width. The sheet usually comes over the wire double width, and slit up the middle in this last stage. After being trimmed it is wound up upon rollers and taken to the finishing-room. In the finishing-room there is the super-calender roll which gives the finest surface obtainable, and which is only used for the best qualities of paper, such as that supplied to *Belford's Monthly* and other high-class periodicals. When the paper has received the finish proper to it, it goes through a cutting-machine where the continuous sheet is

CUT INTO REGULAR LENGTHS

of three feet or thereabouts; then assorted, packed in bales of convenient size and shape and stored away until finally shipped to its consignment. This last step does not give the company much concern. The railroad passes within fifty yards of the storehouses, but as if this were not enough, a switch has been carried to the entrance to the yard, and the paper has to be transported but a few steps before reaching the freight cars in which it is carried, either direct to customers or to the warehouses at headquarters in Montreal. In Sherbrooke the Canada Paper Co'y has another large establishment situated on the Magog, near its junction with the St. Francis, but these mills are chiefly given to the manufacture of heavy felts and wrapping papers and newspaper. The Windsor Mills are usually employed in making the finer kinds of printing, book and writing papers, and supply most of the leading journals and periodicals in Canada. A department frequently spoken of during the description of the manufacture was the

"RECOVERY HOUSE."

This is too important and interesting a place to be passed over without a brief notice, although our space does not admit of a detailed description of any others of the minor processes. It was thought best to refer to this part at this late stage rather than interrupt the continuous account of the paper-making at an earlier period. The recovery house is a long shed, in which there are four furnaces. But, what furnaces! Thirty-five feet long, twenty feet high in

12 DESCRIPTION OF THE CANADA PAPER CO.'S MILLS.

parts and proportionately broad ; these gigantic fire places are themselves almost the size of an ordinary house. Their use is to renovate the caustic liquor which has expended its strength upon the material boiled in it in the great upright boilers referred to in the reduction of the wood. This boiling weakens the caustic liquor and renders it impure. The caustic liquor is manufactured in the first place from the mixing and heating of soda-ash and lime. The object of the recovery process is to get back the soda-ash, and for the obtaining of it from the weakened or "black" liquor the furnaces are used.

INSIDE THE FURNACES

are a series of shelves or pans, into which the black liquor (which has been carefully collected after the wood-boiling) is run. The fires are then started and urged until a heat is attained sufficiently great to burn out the water and silica and resinous matter from the wood, and a black soda-ash is left. This is similar to the original ash, except in color, and is used similarly. But the "recovery" is only one sample of the care exercised to prevent waste, and to utilize every possible means of economizing material in the manufacture. The chlorine used in bleaching is similarly saved, as is also the liquid which percolates through the wire in the final stage. It is attention to such comparatively little things which not only here but everywhere makes success. Such is the story, told as briefly and concisely as possible, of the manufacture of paper. Its uses we need not dwell upon ; there is none so ignorant as could not enumerate them. The want of paper, almost as much as the want of printing, it was that kept men in ignorance for centuries, for papyrus and parchment could but ill supply its place. Yet, useful as paper has already proved,

AN EVEN WIDER FUTURE

seems to open before it. There is scarcely a material or metal from wood to iron whose place it does not seem able to supply, or whose ends it cannot attain. Already furnishing wings for man's best thought or proudest calculations, bearing the visible expression of his sweetest melodies, or itself stamped with his likeness, it seems destined to become his actual personal envelopment, the material of the constructions in which his journeys are made, or the means by which his wars shall be carried on. It is an actual fact that clothes and furniture, carriages and vessels have been made from paper ; it is proposed that fire-arms and defensive armor be also manufactured from it. Time-proof it has shown itself, fire-proof and water-proof it is made ; bullet-proof and burglar-proof it may yet be, and prevent crimes which it now only records. The pen may, indeed, be mightier than the sword, but the pen is mighty through the paper.

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